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6. STUDIES OF BEAKED WHALES IN HAWAI'I: POPULATION SIZE, MOVEMENTS, TROPHIC ECOLOGY, SOCIAL ORGANISATION AND BEHAVIOUR

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Ongoing field studies of Cuvier's, *Ziphius cavirostris*, and Blainville's beaked whales, *Mesoplodon densirostris*, around the main Hawaiian Islands address aspects of the biology and ecology of these species. These include: 1) diving behaviour, using suction-cup attached time-depth recorders (Baird *et al.*, 2006a, b); 2) population sizes, using capture-recapture methods with photo-identification data; 3) habitat use, using GIS analyses of effort and sighting data; 4) trophic ecology, using stable isotope analyses of biopsy samples, genetic determination of prey from faecal samples, and direct collection of prey items; 5) site fidelity/movements, through long-term photo-identification, short-term VHF radio tracking, and medium-term satellite tagging; 6) social organisation, through analyses of associations based on photo-ID data and observations of behavioural interactions; and 7) population structure, through genetic analyses of biopsy samples, satellite tagging, and photo-identification.

Directed survey effort around all the main Hawaiian Islands has been ongoing since 2000, with 38,434 km of trackline surveyed through 2006. Cuvier's beaked whales are the seventh-most frequently encountered odontocete (1.27 sightings per 1,000 km off the island of Hawai'i), representing 3.4% of all odontocete sightings. Blainville's beaked whales are tied for the eight-most frequently encountered odontocete (0.86 sightings per 1,000 km off the island of Hawai'i), representing 2.8% of all odontocete sightings.

Capture-recapture estimates of population size take into account correction factors for the proportion of marked animals in the populations. Mark change rates are low, and numerous "marks" for each individual are considered (McSweeney *et al.*, 2007); thus the likelihood of missing matches is low. Models run to date are closed population models, assuming no births, deaths or permanent migration occurs. While these assumptions are likely not true, there is no information available on birth or death rates, or permanent migration. Spatial heterogeneity of sampling has been minimized in recent years, and movements of individuals have been documented over the entire study area (McSweeney *et al.*, 2007), suggesting that spatial heterogeneity of sampling likely does not strongly bias the estimates. Each individual was classified as "not distinctive", "slightly distinctive", "distinctive" or "very distinctive". Only those classified as distinctive or very distinctive were considered "marked" in the analyses.

For Cuvier's beaked whales, based on 22 groups, the proportion of individuals per group that were marked averaged 0.985 (CV = 0.07). For Blainville's beaked whales, based on 20 groups, the proportion of individuals per group that were marked averaged 0.89 (CV = 0.19). For Cuvier's beaked whales, Petersen capture-recapture estimates were undertaken for a number of pairs of years: 2003 – 2004 (estimate = 39 individuals, CV = 0.43); 2004 – 2006 (estimate = 46 individuals, CV = 0.28); 2005 – 2006 (estimate = 44 individuals, CV = 0.43); and pooled 2003/2004 versus 2005/2006 (estimate = 55 individuals, CV = 0.26).

Correcting for the proportion of marked individuals in the population results in a point estimate of 56 individuals (using the pooled 2003/2004 versus 2005/2006 data). For Blainville's beaked whales, Petersen capture-recapture estimates ranged from 73 individuals (CV = 0.34) for 2003 – 2004, to 83 individuals (CV = 0.48) for 2005 – 2006. Using pooled 2003/2004 and 2005/2006 data, the estimate of the number of marked individuals in the population was 125 (CV = 0.30). Correction for the proportion of marked individuals in the population results in a point estimate of 140 individuals.

Despite the limitations of the analyses, it is clear that these populations are relatively small. For Blainville's beaked whales, there is some evidence of sampling both an island-associated population and an offshore population. From directed efforts, 17 groups were identified in depths from 456 – 3,200 m between 2002 and 2006. The 14 shallowest groups (observed in depths ranging from 456 to 1,593 m) had an average of 67% of the individuals seen more than once (SD = 0.31), and all of these groups had at least one individual seen more than once. The three deepest groups (1,783 to 3,200 m) had no individuals re-sighted.

Studies of trophic ecology are ongoing, but preliminary analyses of stable isotopes indicate that Blainville's beaked whales feed at a higher trophic level than do short-finned pilot whales, despite their use of similar habitats and their similar preferences for feeding primarily on cephalopods.

Satellite tagging of four beaked whales, one Cuvier's, and three Blainville's, was undertaken in 2006. Locations of the Blainville's beaked whales were received for periods of 15, 17 and 23 days after tag deployments. All three individuals remained near the island of Hawai'i during the period locations were received, although all three left our study area off the west coast of the island, moving to the northern tip of the island (all three individuals), and one individual moved briefly off the eastern side of the island.

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